Water Quality Status Report No. 118

Ground Water Study of the Lower Boise River Valley Ada and Canyon Counties, Idaho

Idaho Department of
Health and Welfare
Division of Environmental Quality
May 1996

Ground Water Study of the Lower Boise River Valley, Ada and Canyon Counties, Idaho

Conducted by:
Deb Parliman, USGS
Sabrina Nicholls, USGS
Linda Boyle, DEQ- SWIRO

Report Prepared by:
Linda Boyle, DEQ-SWIRO
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ABSTRACT

From July 24, 1995 through October 24, 1995 a total of 335 ground water samples in the Lower Boise River Area were collected by the U.S. Geological Survey and the Division of Environmental Quality, Southwest Idaho Regional Office. This study is a continuation from the 1993-1994 sampling in the Boise area.

Field parameters were measured at each site, prior to collecting samples. All samples were analyzed for basic nutrients, volatile organic compounds, bacteria, and some sites for pesticides. Nitrate, the most prevalent nutrient, exceeded of 10 mg/l in 3% of the well samples. Volatile organic compounds were found in 6.5% of the sampled wells (most common constituents were tetrachloroethylene and trichloroethylene). Total coliform was found in 8% of the sampled wells and fecal coliform was found in 0.6% sites of the wells sampled. Pesticide samples were collected at 21 sites, 71% of the wells were impacted by pesticides (most common constituents were atrazine and simazine).

Two areas of concern were found during this study. Both areas had high nitrate levels and low VOC levels, in addition to either bacteria or pesticides. These areas are located north of Eagle/Star and northeast of Meridian.

INTRODUCTION

Background

This is a continuation of the 1993-94 Boise area sampling project. The results of the first phase of the project can be found in the report "Determination of Nature and Extent of Ground Water Contamination in Boise City and Boise Urban Planning Areas, Ada County, Idaho" (Boyle 1995) at the Division of Environmental Quality, Southwest Regional Office. The figure of page 3 shows the location of the study area and the location of all the wells sampled to date.

The focus for this phase of the study is on the ground water quality within the Boise River drainage area. The project concentrates on the area west of the City of Boise. This area is changing from rural land use to suburban and urban land use.

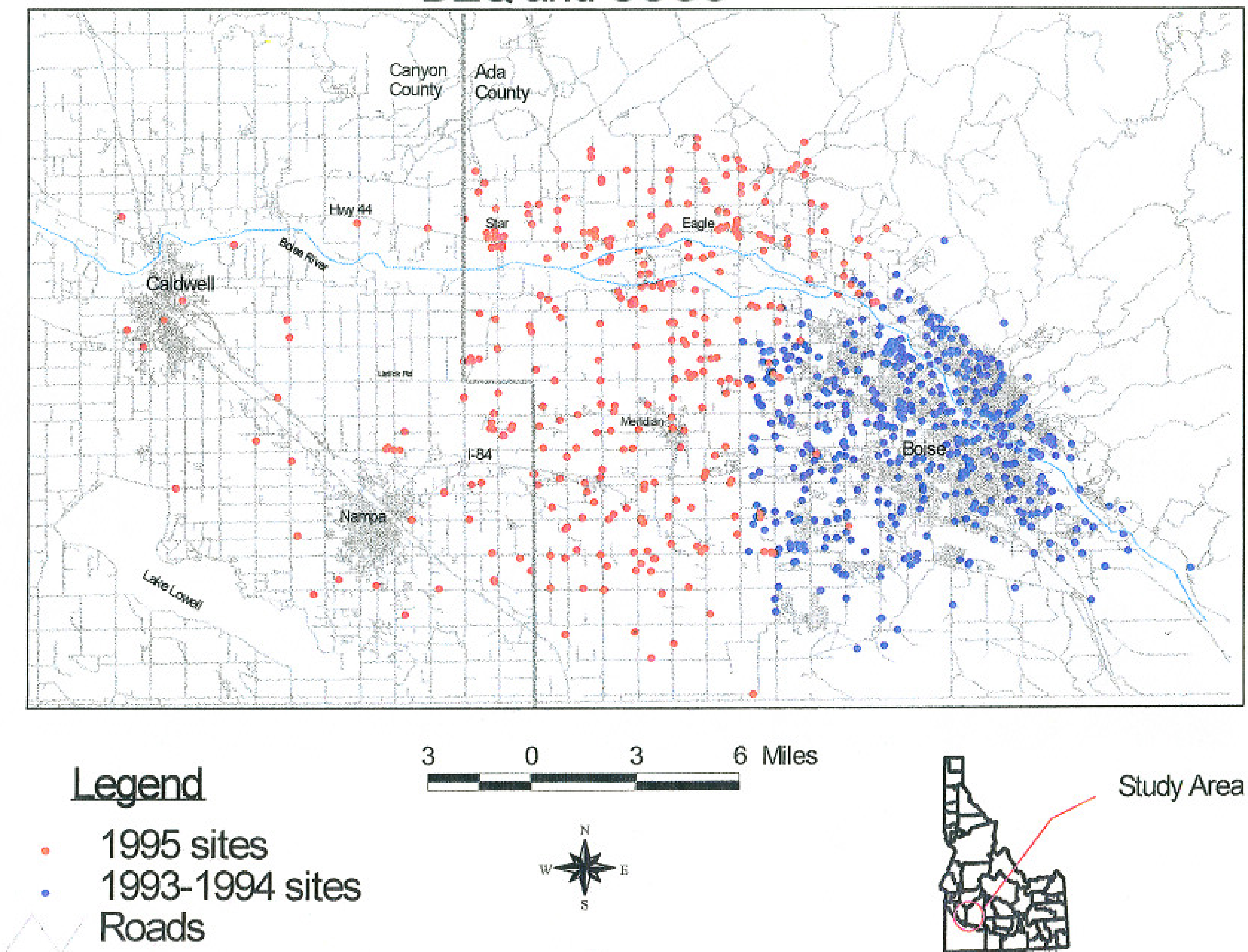
At least 90% of the drinking water in the Boise River drainage area is supplied from ground water sources (IDHW DEQ 1991). The urban, suburban, and rural areas have wells completed in a number of water-yielding zones (IDWR 1995). This report combines all the water-yielding zones into three groups; shallow is less than 150 feet below land surface, intermediate is 150-250 feet below land surface and regional is greater than 250 feet below land surface.

Shallow water zones, less than 150 feet below land surface, are the most vulnerable to contamination from industrial solvents, petroleum products, septic tank drainfield leachate, pesticides, fertilizers, and stormwater runoff. Leakage from unlined canals and ditches recharges the shallow water-yielding zones and causes substantial seasonal changes to the level of the water table. Rising water levels flush contaminants from previously unsaturated soils. Contaminants related to land and water use include nutrients, bacteria, pesticides, petroleum products, and solvents (Parliman 1993-1994).

Naturally occurring ground water contaminants include iron, manganese, fluoride, and radon (Crockett 1994). The regional cold water system is underlain by confined systems of geothermal water. Infiltration of geothermal water can elevate the levels of sulfur and fluoride in drinking water (Parliman 1993-1995).

Previous ground water studies in this area have mainly concentrated on site specific contamination, with a limited scope of information gathered. (See Collection of Historic Information and Data section under Methods and Materials for information on the site specific studies.) The purpose of this study is to document water quality on a regional scale. There are numerous benefits of

Figure 1. Sites Sampled by DEQ and USGS



a regional study for future use in the limited, or local, scale studies for private or agency use in identifying ambient water quality, water and land use, and the location of inventoried wells within the area.

Objectives

The objectives of this study are:

1. Complete a retrospective analysis of existing hydrogeologic information and data on ground water quality.

2. Document historic and current land and water use practices.

3. Analyze ground water samples to determine the nature and extent of contaminants in the shallow (<150 feet below land surface), intermediate (150-250 feet below land surface), and regional (>250 feet below land surface) water-yielding zones.

4. Publish a report on the results of the ground water study.

Project Area

The project boundaries are along the Boise foothills near the Ada County Landfill northwest to Beacon Light Road. West on Beacon Light Road to Ada/Canyon County line. Then south along the Ada/Canyon County line to Lake Hazel Road. East on Lake Hazel Road to Eagle Road. North on Eagle Road to the Boise River and back to the Ada County Landfill. In addition, approximately 50 additional samples were collected in the Nampa and Caldwell area.

Historic and Current Land and Water Use Practices

The Boise Valley has only known permanent settlers for approximately the last 160 years. Prior to 1834, the area was an important meeting place for Indians to conduct trading during their annual Sheewoki Fair (Wells, 1982). The trading would last for months along the rivers of the area.

The migratory life style of the area slowly changed with the fur traders moving into the valley in 1834. Within six years, Boise's fur resources had been depleted. The main business for the few settlers that were able to eke out a living were providing supplies to the people passing through the area on the Oregon Trail.

The discovery of gold in the Clearwater-Idaho City area in 1860 quickly changed the shape of the Boise area and started rapid growth in the valley. The gold rush created booming business for the farmers and the loggers in the area.

Early farming was limited by the availability of water for the crops. By 1911 the valley had undergone significant changes with the construction of Diversion Dam and Arrowrock Reservoir, along with four major canals; the Ridenbaugh, Farmer's Union, New York and Phyllis canals to carry water miles away from the Boise River for farm use. Anderson Ranch Reservoir was started to provide an increase of irrigation water to the farms. The last dam to be built for irrigation storage was Lucky Peak Dam and was constructed by 1952.

Surface water is not been the only source of irrigation water in the valley. Ground water pumped from irrigation wells is used to supplement surface irrigation water where surface water is limited or cannot be utilized. Such large amounts of irrigation water, surface and well water, being used in a semi-arid desert has significantly altered the water table level in the shallow zones of the aquifer in the valley. The use of surface water has raised the water table level in some areas considerably.

High water tables in some areas have created water logged soils, crating problems for farmers. Consequently, in these areas, drains have been dug to allow drainage of the water logged soils.

During the 1950's, there was a shift from septic fields to piping the waste to sewage treatment plants (Dion, 1972) in and near the cities. This also increased the development of rural land into urban use. The change of farm land to residential and business use continues today.

Farm land evolving to residential and business use is also changing the irrigation practices of the area. Residential homes and businesses use less surface irrigation water which lowers the amount of possible recharge water to the shallow zones of the artificially raised aquifer. Lowering of the ground water table may be compounded by residential and business properties using ground water for landscaping purposes, rather than surface water. The lower water table could impact the wells that have been drilled into the shallow zones of the aquifer.

The late 1970's brought the most recent change to the industrial picture with computer companies moving into the valley. Computer companies require large quantities of "clean" or uncontaminated water to manufacture computer components. The potential for problems with the increased pumping of ground water by business and residential use is being addressed on the southeast edge of Boise (Squires 1993).

Climate

The valley has a semi-arid, temperate climate characterized by cool, wet winters and warm, dry summers (Dion 1972). The mean annual temperature is 51 degrees fahrenheit. The mean annual winter and summer temperature is 33 degrees fahrenheit and 71 degrees fahrenheit, respectively. The mean annual precipitation is 11 inches; majority of the precipitation falls during the winter as snow.

Geology

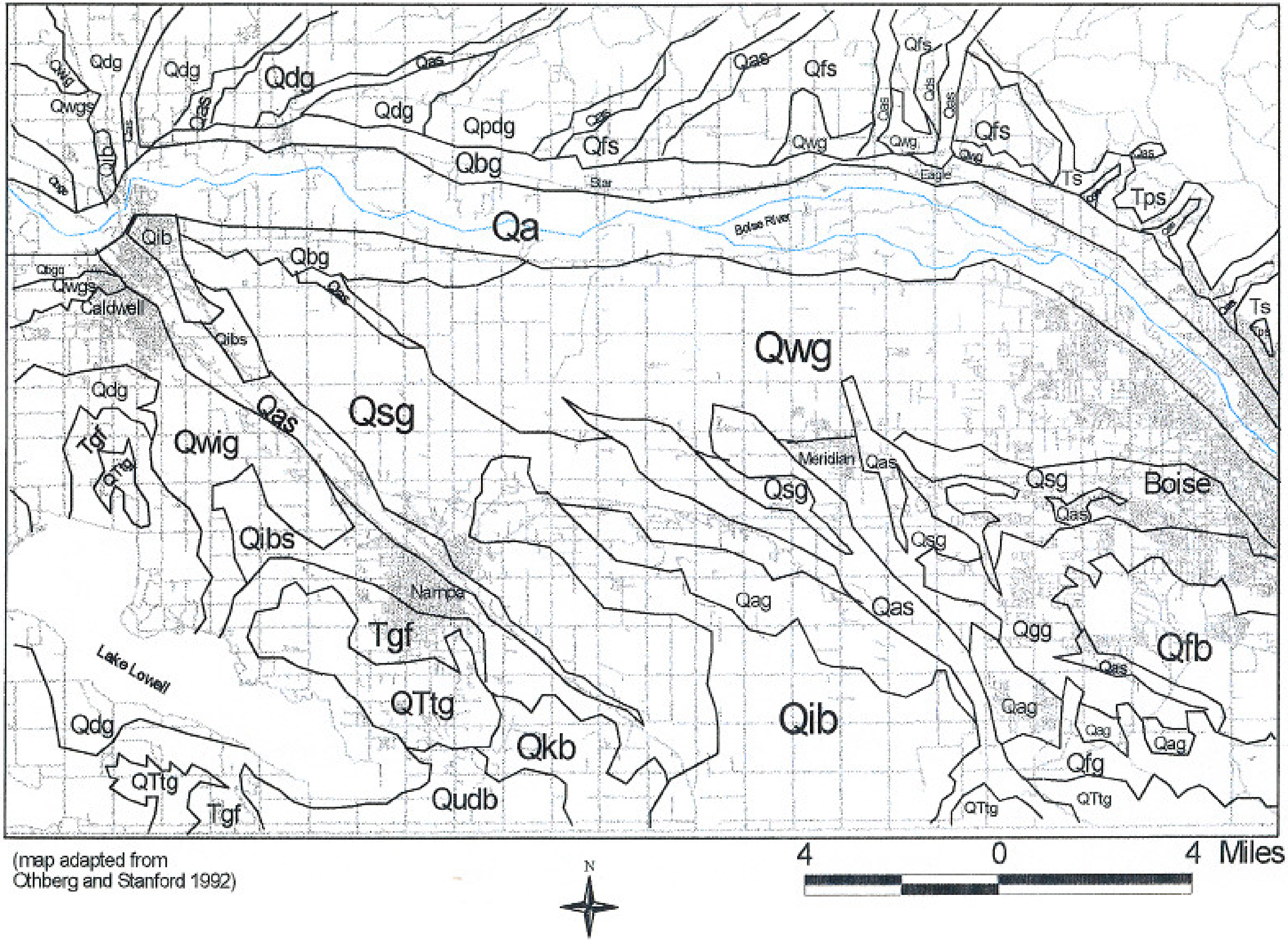
The valley has a complex geologic history of erosion, sedimentation, and intrusion. Consequently, an accurate determination of age relationships between lithologic units, especially the younger sands and gravels, is often difficult. Rock units ranging in age from Miocene to Holocene underlie the area (Dion 1972). See the figure on page 7 for a geologic map of the valley.

The Idaho batholith is the oldest rock unit that is exposed. It is composed of gray granite that weathers into rounded slopes. Rocks of the Idaho batholith probably underlie the entire area at depth and form a structural troughlike basin in which younger rocks were deposited (Dion 1972).

Columbia River basalt of Miocene and Pliocene age can be found unconformably in the valley. Overlying the Columbia River basalt are basalts of the Snake River Plain. The Snake River Plain basalts are of late Pliocene and early Pleistocene age. There is abundant evidence of minor faulting and tilting within the formation (Dion 1972).

The basalts and granitic rocks have undergone extensive weathering and erosion. As the glaciers of the Pleistocene epoch melted the valley saw torrential rivers until a basalt flow formed a dam causing the river to form a lake. The lakes lasted until a path through the basalt was created by the water. This repeated action of fast to slow moving water through the valley created from 0-5000 feet of sedimentary fill (Lindholm 1993). Finer sand and clay layers would be deposited in the slack waters of the lake conditions, then rock of sorted sizes were carried and deposited by the faster moving waters (Othberg 1994).

Larger rock deposits and isolated basalt remnants on the higher, outer edges of the moving water survived some or all the changes created by the water (Dion 1972). The rock deposits helped to build the terrace that can be found as one travels away from the Boise River floodplain.



(map adapted from
Othberg and Stanford 1992)

Figure 2. Geologic Map of the Lower Boise River Valley

Figure 3. Legend for the Geologic Map
(adapted from Othberg and Stanford 1992)

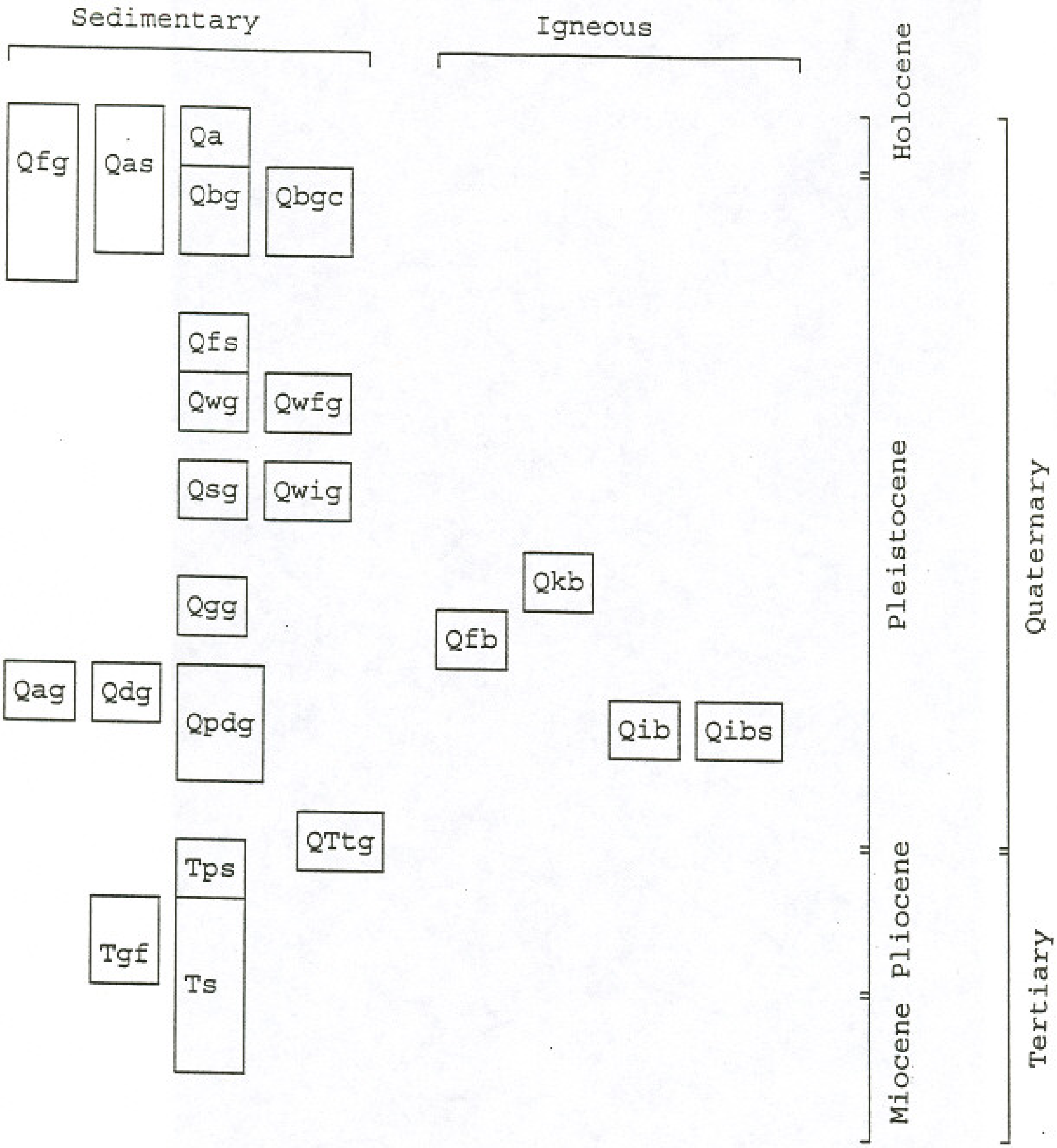


Figure 4. Map Units for the Geologic Map
(adapted from Othberg and Stanford 1992)

Sedimentary
Quaternary Sediments
Alluvium and Colluvium

Deposits of floodplains, alluvial fans, side-stream terraces, and landslides.

Qa ALLUVIUM OF BOISE AND SNAKE RIVER – Sandy cobble gravel upstream grading to sandy pebble gravel downstream. Mostly channel alluvium of the Boise and Snake Rivers. Thickness 6-14 meters. No Pedogenic clay.

Qfg ALLUVIUM FAN GRAVEL – Sandy pebble and cobble gravel where formed from reworked Tenmile gravel (QTtg) and sand and granule gravel where formed from weathered granite (g). Primarily formed by Pleistocene debris flows and local high-energy streams during times of greater runoff. Loess 1-2 meters thick discontinuously covers surface of gravel. Patterned ground present. Amount of pedogenic clay and presence of duripans varies.

Qas SANDY ALLUVIUM OF SIDE-STREAM VALLEYS AND GULCHES – Medium to coarse sand interbedded with silty fine sand and silt. Sediment mostly derived from weathered granite and reworked Tertiary sediments. Thickness variable. Minor pedogenic clay and calcium carbonate.

Qfs SAND OF INCISED ALLUVIAL FANS – Medium to coarse sand interbedded with silty fine sand and silt. Mostly reworked Tertiary sediments deposited in local alluvial fans. Thickness 1-15 meters. Pedogenic clay 10-20%; duripans locally present.

Bonneville Flood Deposits

Consists primarily of fine-grained sediments of the Bonneville Flood slack water that inundated the Snake River Valley and the lower Boise River Valley. Includes gravels deposited in high-energy flood channels. The surface of sediments deposits by the Bonneville Flood show minor accumulations of pedogenic clay and calcium carbonate. Slack-water sediments bury loess and soils of older surfaces.

Qbgc CLAY OF BONNEVILLE FLOOD SLACK WATER – Light tan silty clay 1-2 meters thick. Deposited by slack water of Bonneville Flood upstream from Parma. Buries gravel of Boise terrace.

Qgg	GRAVEL OF THE GOWEN TERRACE
Qag	GRAVEL OF THE AMITY TERRACE
Qdg	GRAVEL OF THE DEER FLAT TERRACE
Qpdg	GRAVEL OF THE DEER FLAT AND PRE-DEER FLAT TERRACES, UNDIVIDED
QTtg	TENMILE GRAVEL

Tertiary Sediments

Tps	SAND OF THE PIERCE GULCH FORMATION
Tgf	GLENNS FERRY FORMATION
Ts	SAND AND MUDSTONE OF STREAM AND LAKE SEDIMENTS

Igneous Rocks
Quaternary Basalts

Basalt lava flows primarily erupted from three sources during the Pleistocene: the northwest-southeast axis of the western Snake River Plain; Smith Prairie; and along the edge of the plain southeast of Boise. The basalts inundated ancestral valleys and plains. Their resistance to erosion helped preserve the terrace remnants they cap. The early Pleistocene basalt flows diverted the Boise River northward and the Snake River westward.

Qib	BASALT OF LUCKY PEAK
Qkb	BASALT OF KUNA BUTTE
Qfb	BASALT OF FIVEMILE CREEK
Qibs	BASALT FLOWS OF INDIAN CREEK BURIED BY LOESS AND STREAM SEDIMENTS

Hydrogeology

The Boise River valley ground water system is primarily within unconsolidated deposits of silt, sand, clay and fine gravel (Graham and Campbell 1981). Water quality within the Boise River valley ground water system varies by the strata within the sedimentary layers that the water flows through. The zones of the aquifer are interrelated, with clay layers functioning as limited divisions to the water bearing zones (IDWR 1995). The overall general direction of the ground water movement is to the northwest as shown in the figure on page 12.

This regional cold water system is underlain by confined systems of geothermal water (Wood 1983). The emphasis of this report is only on the regional cold water system.

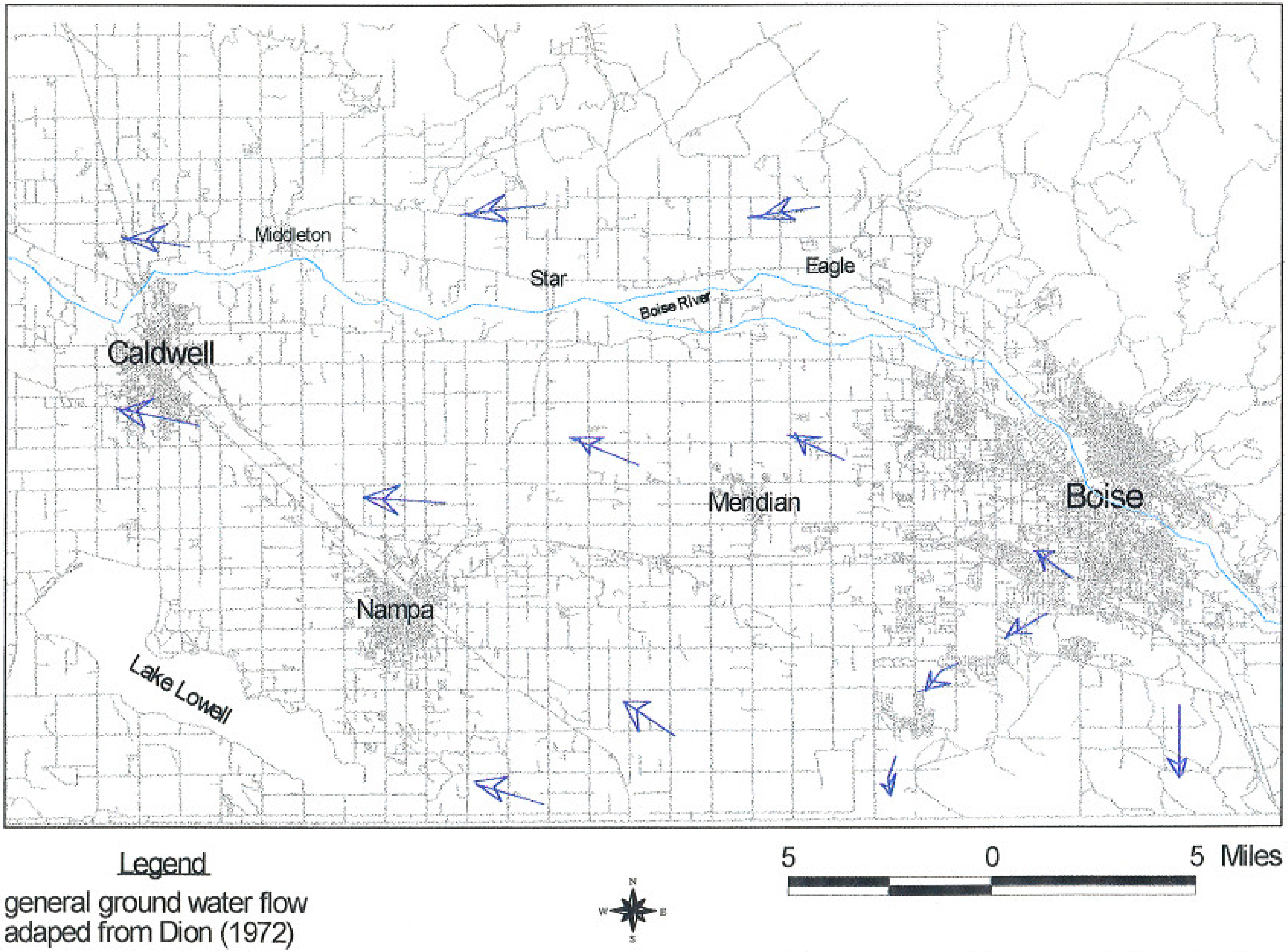
METHODS AND MATERIALS

Collection of Historic Information and Data

A number of sites with impacted ground water were found during the previous stage of this project in the Boise area by DEQ and USGS. Sites with known ground water contamination where located in the files at the Division of Environmental Quality – Southwest Idaho Regional Office (DEQ-SWIRO). Some sites have been identified by the Statewide Ground Water Quality Monitoring Program. The figure on page 13 shows the location of all sites found with historic data.

The Statewide Ground Water Monitoring Program has identified domestic wells with elevated concentrations of nitrate and/or pesticides. (Safe drinking water levels are based upon U.S. EPA 1995 Drinking Water Regulations and Health Advisories). One domestic well in northwest Boise was identified to have nitrate levels greater than the maximum contaminant level (MCL) of 10 milligrams per liter. An area north of the Eagle/Star area has two domestic wells that are impacted with nitrates above the MCL and a third just below the MCL for nitrate. In addition to nitrate these wells were found to have been impacted by 1,2-dichloropropane, 1,2,3-trichloropropane, and Dacthal.

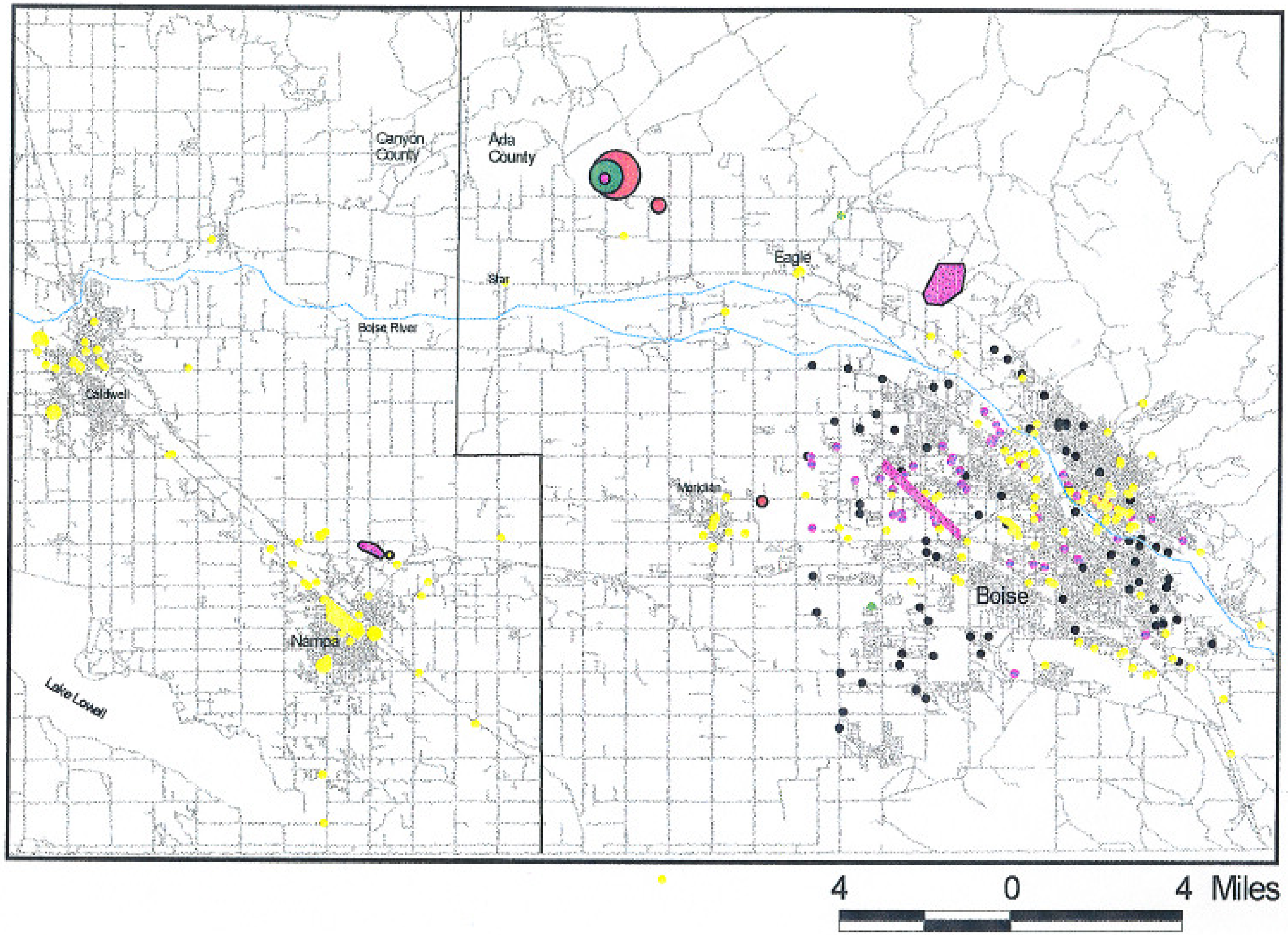
Files at DEQ-SWIRO contain information with ground water impacted by tetrachloroethylene and petroleum products. Two files refer to the tetrachloroethylene contamination in northwest Boise and north



Legend

general ground water flow adaped from Dion (1972)

Figure 5. Ground Water Flow in the Lower Boise River Valley



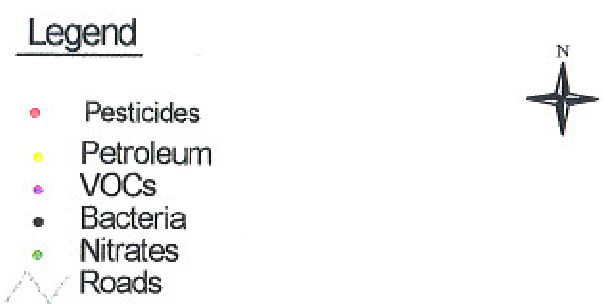


Figure 6. Location of Historic Ground Water Impacts

of Nampa, both sites have domestic wells that have been impacted. The petroleum contamination within the cities of the study area are site specific with contamination defined by monitoring wells installed for delineation and/or remediation purposes. Ongoing remediation is taking place at four sites in Eagle, seven sites in Meridian, sixteen sites in Nampa, thirty-nine sites in Boise, and twenty-two sites in Caldwell (DEQ 1996).

There are a number of well sites with VOCs and bacteria in the Boise area. These sites were identified from previous sampling conducted by DEQ and USGS. These results can be found in the report, "Determination of Nature and Extent of Ground Water Contamination in Boise City and Boise Urban Planning Areas, Ada County, Idaho" (Boyle 1995) at the Division of Environmental Quality, Southwest Regional Office.

Selection of Wells for Sampling

Wells that were selected for sampling had pumps installed in them to avoid the costly and time consuming process of decontamination between wells. Domestic and irrigation wells were prioritized to determine if they would be an adequate selection for the project objectives. First priority were wells that had historical data from previous sampling or studies. Second priority were the wells with a well driller's log available from the Idaho Department of Water Resources. Third priority were wells that were known in a crucial area that did not have an available well driller's log or had prior sampling results.

A diagram of each well was made by going to the area and sketching the well location. The final selection of wells was based on a thorough coverage of the sampling area, to eliminate clustering of wells. A map of well locations is shown in the figure on page 15.

A permission letter was sent to each owner of wells selected for sampling. Additional wells in a given area were chosen if a permission letter for that area was not returned or permission was not granted.

Parameter Selection and Rationale

<u>Field Parameters</u>

Specific conductance, pH, water temperature, and dissolved oxygen were utilized to determine when the well had been adequately purged prior to sampling, these measurements were taken approximately every five minutes. After all field parameters had stabilized for

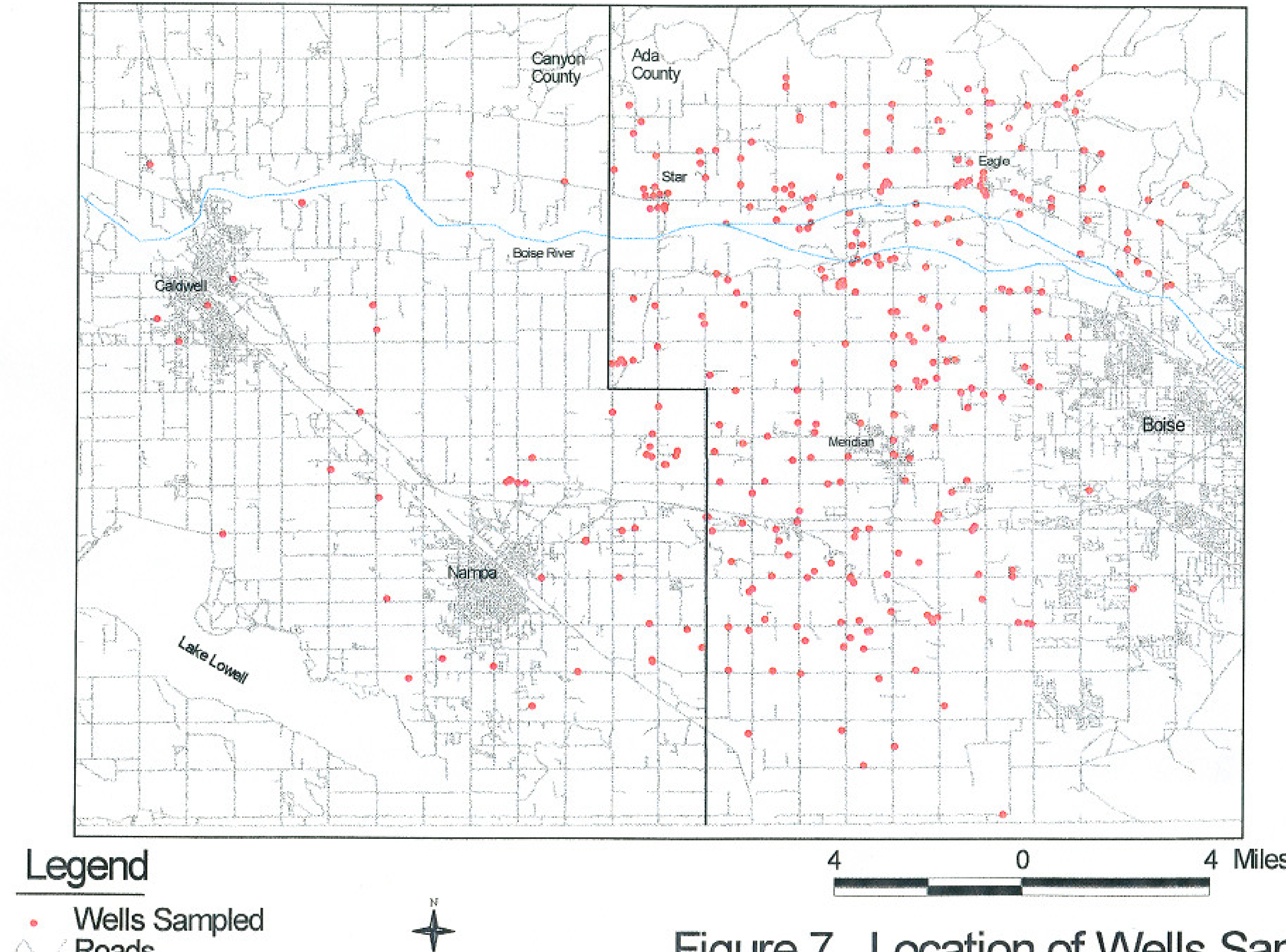


Figure 7. Location of Wells Sampled

at least two measurements, the samples were collected.

Total Coliform and Fecal Coliform

Bacteriological analyses are the principle tests used to assess the sanitary quality of water and the potential health risk from waterborne disease (Sylvester 1990). Total and fecal coliform can show a possible impact from land and water use, failing septic systems, and/or stormwater.

Volatile Organic Compounds

Volatile Organic Compounds (VOCs) analyses can show a potential impact to ground water from human made and human introduced compounds. Water Quality Standards and Wastewater Treatment Requirements (IDAPA 1993) state a potential health hazard with drinking water with small amounts of VOCs, in the parts per billion range.

Metals

Metals are sampled in some of the wells in the project to address the possible differences of metal concentration in the different water-yielding zones of the aquifer. Samples are also taken where there is a suspected potential problem from human impact, such as at former landfill sites.

Ions

Ions are sampled in some of the wells in the project to address the possible differences of ionic concentration in the different zones of the aquifer.

Nutrients

Nutrients are found naturally in ground water, different areas and zones of the aquifer have different concentrations of nutrient constituents. Increased levels can show human land and water use impact.

Radon

Radon was selected to obtain a view of the radon concentration in the Boise Valley in the different zones of the aquifer. Radon is being considered to be regulated by EPA for public water supply systems. The Boise Valley has shown significant concentrations of naturally occurring radon.

Pesticides

Pesticides in ground water show an impact from agricultural land use. The Boise valley has historically had the residential growth taking place in the former agricultural areas.

Sampling/Collecting Methods

At each site, the outside faucet or hydrant located closest to the well was chosen as the sampling location. A hose was connected to the faucet or hydrant with a splitter and a short section (approximately 5 feet) of hose placed at the end. The faucet or hydrant was then turned on the full amount possible. The longer or main hose was given the majority flow of water with a controlled amount of water flowing into the bucket from the shorter hose.

A bucket was used to best imitate a flow through chamber in order to best represent the zone or zones of the aquifer in which the well was installed. The meters used to collect the field parameter data were placed in the bucket. The meters used were for measuring temperature, pH, specific conductance, and dissolved oxygen.

Measurements with the meters were taken about every five minutes and recorded on a field sheet. Sampling time was determined when the meters had stabilized for at least two measurements. The stabilized field parameter measurements indicate chemical stability of the ground water entering the well and directly being pumped out. This was important in order to sample for aquifer characteristics versus the water that was allowed to sit in the well casing and possibly being altered by the materials of the well casing and the atmosphere.

After the chemical stability of the ground water has been determined, the hoses were removed. The faucet or hydrant was allowed to run for 10-15 seconds prior to the samples being collected. Latex gloves were put on in order to eliminate cross contamination from the hands. An in-line filter, with 0.45 micron filter was attached to the faucet or hydrant. Water was allowed to run through the filter for 10-15 seconds. Then samples were collected for nutrients and ions, each in a separate triple field rinsed 125 ml polyethylene bottle filled to the neck of the bottle and tightly capped.

The in-line filter was then removed and a small stream of water was allowed to run from the faucet in order to collect the remaining samples. A bacteria sample was collected in a sterile 250 ml polyethylene bottle, the bottle was filled to the neck and tightly capped. Care was taken to not touch the faucet or hydrant with the sample bottle for all samples collected.

A 500 ml polyethylene bottle was triple rinsed in the field and filled to the neck and tightly capped. This sample was used to run a HACH nitrate test at the USGS Laboratory.

Three 40 ml glass bottles were used for collecting VOC samples. Two of the bottles were preserved in the field with HCl. The third bottle was not preserved since it was ran through the portable gas chromatogram at the regional USGS Laboratory in Boise, Idaho. All bottles were filled to the top, with meniscus at the lip of the bottles and then tightly capped with a teflon-lined cap. The bottles are checked for air bubbles, if there was a bubble more water was added to remove the air and then tightly resealed.

Radon was collected with a syringe. The syringe was triple rinsed with the flowing water. The needle of the syringe was then placed directly into the water stream. A few volumes of water was collected and pushed through the syringe. A full syringe volume was collected, making sure that no air bubbles were present. All but 15 ml are removed as the lid of a 25 ml glass bottle with 10 ml of mineral oil was carefully removed and 10 ml of the water in the syringe was put into the bottle with the needle placed at the bottom of the bottle so that the ground water sample was placed below the mineral oil, the remaining 5 ml in the syringe was not used for the sample. The bottle was vigorously shaken after tightly replacing the cap.

All samples were labeled with site identification number, project number, type of analysis, date, and time. These are then placed in a cooler with ice, until arriving at the USGS Laboratory at the end of the day.

At the site, a clean beaker and graduated cylinder was triple rinsed with the flowing water. The 50 ml of water was measured with the graduated cylinder and placed in the beaker. This water was then titrated with H_2SO_4 to calculate alkalinity and bicarbonate.

The field sheet was filled out to note all necessary information of the sampling procedure at every site, any comments relevant to the site and a chain of custody sheet was filled out for the VOC samples. A copy of the field sheet and chain of custody sheet can be found on page 20 and 22, respectively. All equipment used at each site was triple rinsed with deionized water then carefully packed to be re-used at the next site.

At the regional USGS Laboratory in Boise, Idaho all samples, except the 500 ml and 125 ml polyethylene bottle and the unpreserved VOC sample, were placed in the sample refrigerator until they were packed on ice and shipped to the USGS Laboratory in Arvada, Colorado. The sample in the 500 ml polyethylene bottle was used to run the HACH NO2/NO3 at the USGS Laboratory. The sample collected in the 125 ml polyethylene bottle was used to plate for total bacteria and fecal bacteria. The unpreserved VOC bottle was analyzed with a Photovac 10-S Portable Gas Chromatograph to determine presence or absence of VOCs. If VOCs were present, the duplicates are shipped to Alpha Analytical Laboratory in Sparks, Nevada.

Frequency

Sampling started in July 1995 and continued until the end of October 1995. 335 domestic and irrigation wells were sampled one time for this project.

RESULTS

Well Depths

Well depths were grouped into three ranges for this project. Wells that were less than 150 feet below ground surface are considered shallow. Wells greater than 150 feet and less than 250 feet below ground surface are considered intermediate. Wells greater than 250 feet below ground surface are considered regional. These ranges are an arbitrary choice and not dependent on geology. See the geology section of this report for more information on the geology. The breakdown of the depths of the wells sampled are listed in Table 1 on page 23.